Space Weather Technical Forecast

Issued on Saturday, 24 September 2022 at 01:25 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of G1 mainly Day 3 due to possible CME arrival(s). Daily Chance of R1, brief Chance of Active electron fluence over UTC weekend.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity measured at L1 by GOES16 and 17 has been Moderate with a slow undulation in background X-ray flux in low C-class, with an observed M-class flare at 23/18010 UTC from a new region (AR3110) on the northeastern limb. . AR3105 in the southeastern quadrant is currently the largest group with little change in recent hours Eki/beta. There are six numbered regions on the current disc. AR3108 and AR3102 have also not displayed signs of growth in recent hours. AR3107 and AR3109 have shown rather more development.
Coronagraph imagery in the period was dominated by a large, wide-angled but apparently slow partial halo Coronal Mass Ejection (CME), first visible from late morning UTC on 22 September in Lasco C2. This CME has been analysed at length and is now thought likely to be related to the then-rapid emergence of AR3109 - probably from one of the attendant coronal dimmings observed in AIA 211. Of these dimming, the CME perhaps most likely left the disc around the dawn period UTC on 22 September. The latest MOSWOC Enlil run puts arrival of this feature around 26/0100UTC, i.e. the turn of the UTC day Sunday 25 September into Monday 26.
An earlier faint CME from the southeast disc on 21 September should (narrowly) maintain its independence as a resolved feature, perhaps arriving as a glancing blow just ahead of its sibling later on 25 September. Both events carry low confidence, but are the only CMEs in the forecast at present. A large filament eruption and CME observed around 23/1400 UTC has been analysed and misses Earth, and a CME from the Moderate class flare will probably miss Earth quite comfortably, and has yet to be analysed.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR and ACE at L1, was of uncertain character, with SSBC(s) in evidence, but perhaps also the fast wind from coronal hole 25, with lower intensity than expected, and more tenuous connection.
The solar wind speed exhibited a slow decline at first in the 24 hours, but showed a discontinuity and subsequent rise from 23/1900UTC to slightly elevated levels. The solar wind density was at Average to slightly above Average levels peaking near 18ppcc immediately before the main speed increase, perhaps a very brief CIR or SSBC, around 23/0130UTC before an ensuing decline into single figures. The IMF peaked at Moderate levels otherwise was Weak. The north-south component, Bz, was also at Weak to Moderate levels in the range of +/-8nT. The phi angle was changeable starting positive (away from the Sun), with a spell of negative orientation (towards the sun). The net result of the above solar wind measures was for provisionally Quiet to Unsettled (Kp1-3).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16, remained very close to Background levels. High energy electron flux (greater than 2 MeV) was at Normal Background to Moderate levels, with peak value 373 pfu at 23/1610 UTC. The associated 24-hour fluence remained well below the Active (1e8 integrated

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pfu) threshold. Observed fluence at 24/0000UTC was 5.94e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is forecast to be Low to Moderate, with further C-class flares Expected and a with an ongoing Chance (50%) of M-class flares. The main flare risk remains from AR3105 and AR3107 in the southeastern disc.

Solar Wind / Geomagnetic Activity: This forecast period comprises the high speed stream related to coronal hole fast wind (from CH25/+), and up to two low confidence CMEs on days two and three (Sunday 25 and Monday 26 September). For a full discussion of this, please see the Geomagnetic Activity section, however the upshot is a peak Chance of G1 in the next 24 hours and again between the UTC days of 25 and 26 September, else falling to a Slight Chance.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES16, is expected to persist at Background levels.
The high energy electron flux (greater than 2 MeV) is expected to be at Background to Moderate levels at first, probably rising in response to CH25's fast wind for a time over the UTC weekend. Later in the four days, either or both of a pair of CMEs may again attenuate counts at GEO to lower the risk of prolonged exceedence of High flux. The associated 24-hour fluence is expected to stay below the Active (1e8 integrated pfu) threshold for much of the period, but perhaps showing a Chance of approaching this for a time over the UTC weekend.

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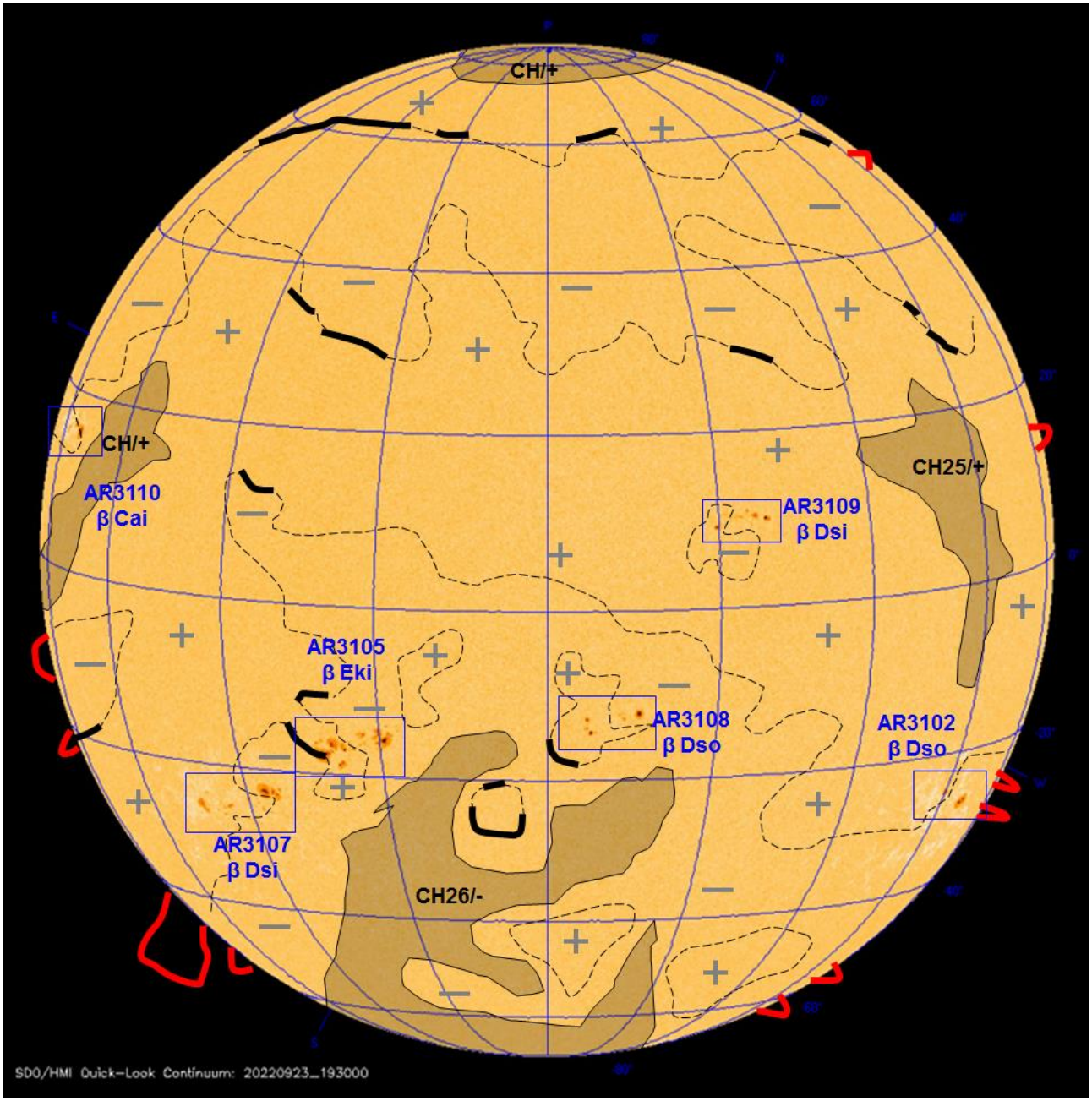
Figure 1. Solar Analysis Valid 2000 UTC, 23 September 2022.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Met Office Space Weather Technical Forecast

Geomagnetic Storms:

This forecast period comprises coronal hole fast wind (from CH25/+), and up to two low confidence CMEs on days two and three (Sunday 25 and Monday 26 September). The coronal hole forecast comprises just one feature: Ch25/+. Connection to this feature appears to have been initiated with solar winds around 450km/s currently observed, and indeed now hinted at by STEREO A PLASTIC measurements (although there are significant data gaps due to regular eclipses around the equinox). There remains a risk of G1s on Day 1, Saturday 24 September.
The CME forecast is much more complex. Coronagraph imagery is significantly clouded in recent days by numerous small emissions, periodically rendered more inconvenient for analysis by data gaps in triangulating STEREO A imagery. The current best estimate involves up to two Earth-bound CMEs. Firstly, a slow CME seen late in the UTC day of 21 September leaving the southeastern quadrant, with no ascertained source, but most likely from AR3105. Secondly, a more assured CME release seen heading mainly north and west of the Sun-Earth line from late in the UTC morning on Lasco C2. The source of this second CME is likely to be the rapid emergence of AR3109, however the precise emission time is more speculative, with several small dimmings in AIA 211 that could be progenitors.
Of the above two CMEs, the second carries a more confident Earth-bound trajectory (although still with significant uncertainty). Current MOSWOC Enlil solutions maintain these two CMEs as distinct features (just) with arrivals late in the UTC of 25 September and around the turn of the UTC day of 26 September. These CME should serve to prolong the tail of risk from the coronal hole fast wind from CH25/+, probably seeing out Monday 26 with a Chance of G1 before abating after the end of this four-day forecast period.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	20	10	30	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
22/0532	Partial	Inferred SE disc, perhaps AR3105	SE disc	309	Late 25 Sep	Source uncertain, very lo confidence. Probably independdent from later CME
22/2058	Partial	Inferred AR3109	Centre NW disc	400	26/0100UTC	Inferred source, lo confidence, mainly N and W of Sun-

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						Earth line.

Radio Blackouts - X-Ray Flares:

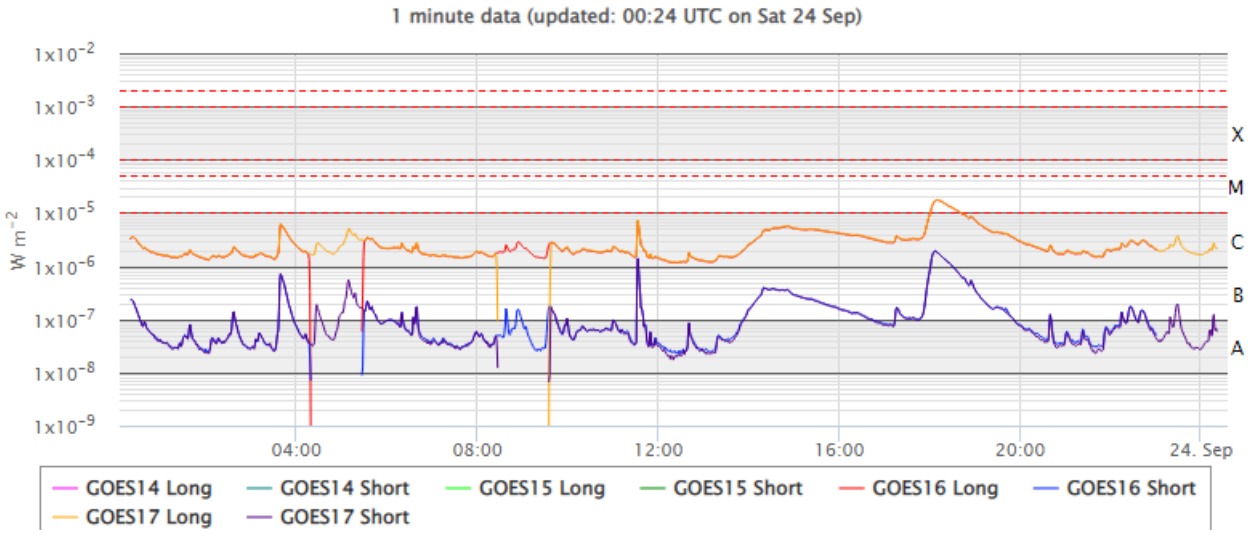
There are currently six numbered sunspot regions on the visible disc. The largest and most complex group remains AR3105 in the southeast, Eki/Beta. Despite its appearances, it remains the case that this group has under-delivered compared to similar groups in the historical records, perhaps because of its presumed age, or its hitherto simple Beta classification.

Also of note on the disc is the possible CME-producing AR3109, which emerged rapidly after midweek UTC and is now classified Dsi/Beta classification, with some recent development in the intermediate spots. Other groups on the disc were less noteworthy, with more stable behaviours.

The far side appears to be populated by numerous large regions of at least plage according to recent soundings, with these arriving in succession into the next working week, to be assessed as and when they materialise over the limb. All considered, there is a daily Chance (50%) of M-class flares, revised down from raw values for the current disc to better match observed activity.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	50	50	40	40
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 2:Latest plot of X-ray flux with M-class flare in UTC evening of 23 September.



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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10MeV) observed by GOES16 is expected to remain at or very close to Background levels. The main flare risk sunspots currently populate the southeastern disc, however their gradual westward transit will see an overall slight increase in the risk of S1+ in the period, with AR3105 probably offering the most significant contribution.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2 MeV) as observed by GOES16, is currently in the Normal Background to Moderate range.

The arrival of the fast wind of CH25/+ will probably enhance electron populations at Earth, with High flux levels perhaps developing during days two and three (25 and 26 September) once initial geomagnetic activity subsides. Confidence in this occurring is now dented by the possible pollution by faint partial halo CMEs - one from 21 September and one from 22 September, with the latter the more likely to be impactful, perhaps sweeping up its forerunning sibling in a united front.

The associated 24-hour fluence is expected to stay below the Active (1e8 integrated pfu) threshold through most the period, but possibly rising above for a time in the possible lull between CH25/+'s incidence and any later CMEs.

MOSWOC REFM is not considered useful in the above scenario, given differences in CH25/+'s appearance to last pass and the presence of up to two transients later in the period.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	20	40	20	30
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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